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Effects of Spacing and Embellishment on Memory for the Main Points of a Text

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20. Abstract (Continued)

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Abstract

An advantage has been found for acquiring text book knowledge by studying textbook summaries rather than reading the original prose (Reder and Anderson, 1980). Two studies are presented that help to establish the cause of the summary advantage. One possible cause is that reading summaries allows the subject to re-read the main points at spaced intervals, and spaced practice is superior to massed practice. A second possible cause is that the presence of details distracts the subject's attention away from the critical ideas that should be attended to. In Reder and Anderson (1980) these two factors were confounded, but are unconfounded in the present studies. The results indicate that both possible causes, spaced practice and the absence of details, have significant, independent and positive effects on retention of the central ideas of a passage.

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This research is concerned with understanding some of the effects of details in a typical textbook format on learning from such a text. When one considers that college textbooks are hundreds of pages and contain tens of thousands of facts, one can not seriously expect a college student to master all the facts on all the pages. Given that mastery of all the ideas is not expected, what are students intended to learn and why are so many details included in the text?

Texts are intended to communicate a set of skills for reasoning and thinking cogently within the field. They include a large number of details to support the central ideas of the book. These details acquaint the student with the argument structure of the field. They may also persuade the student to believe the claims the text is making.

These potential functions of details do not address the issue of whether details support memory for the main points of a text. An important question is whether the inclusion of details is justified on the grounds of helping to retain the main points. One argument is that embellishments allow the reconstruction of the main points. Details imply the main point, although the converse is not true. The details, then, could allow the student to induce a central idea when it has been forgotten.

There are alternative arguments that can be made for why details should not support memory for the important ideas. Cognitive scientists (e.g., Crothers, 1972; Frederiksen, 1975; Kintsch, 1974; Kintsch and van Dijk, 1975; Mandler and Johnson, 1977; Meyer, 1975; Rumelhart, 1975; Stein and Glenn, in press; Thorndyke, 1977) have proposed theories of the structure of text which involve hierarchical representations of the idea units in the text with the more important propositions represented higher in the hierarchy. The predominant notion is that one can only access details if one has first accessed the higher order ideas that subsume them. Thus, memory for main points is supposed to support memory for details and not vice versa. Indeed, investigations of these

representations have found that propositions higher and more central in these hierarchies are better recalled, more accurately recognized, and more rapidly verified (e.g., Kintsch, 1974; Kintsch and van Dijk, 1975; Meyer, 1975). Of course, none of these results in and of themselves imply that details do not support memory for the main points.

A recent paper by Reder and Anderson (1980) investigated whether or not details benefit memory for the main points of a passage. Subjects read one passage in the original text form and a second passage in a summarized form. The summary form sacrificed all the redundancy and embellishments that come from the inclusion of details. The summaries were devised to retain the main points of the chapter, but not save the paragraph style. One unembellished fact was listed per line.

To our surprise, all seven experiments indicated that subjects learn information better when they read an abridged or summarized version of the original text than when they read the original chapter. The advantages for summaries were maintained at retention intervals of 20 minutes, 1 week, and 6 to 12 months. Summaries were superior both for questions that directly tested assertions from the text and for inferences that required the subject to combine facts that had been studied. Subjects also learned new, related material better (regardless of input form) when prior information had been learned in summary form. The retention advantage was also manifest in reaction times, such that subjects answered questions faster (and also more confidently) when they read the summaries. Even when the main points in the text were underlined, subjects performed better with summaries.

The purpose of this investigation is to try to determine the cause of the summary advantage. Two hypotheses occurred to us:

1. Summaries allow subjects to focus more attention on the relevant or important information than is possible when they must assimilate all the information in a text.

2. The summaries have the advantage of spaced study whereas the text has massed study.

Because there is less material to read in a summary, the material can be read several times.

Rather than focussing on each main point in the summary for a long time, a subject can cycle through each main point several times at spaced intervals. In contrast, the prose can be thought of as consisting of one main point followed by its embellishing ideas, then a second main point and its corresponding details, etc. Because there is more information to read, a subject will probably only be able to read the prose version once in the allotted time. (Most of the earlier experiments equated study time in the two conditions. However, performance was superior in the summary condition even when the prose condition was allotted three times as much study time.)

The first argument, the focus of attention argument, is supported by related studies in the reading literature (Frase, 1967, 1968, 1971, 1972, 1975; Rothkopf, 1966, 1972; Rothkopf & Bisbicos, 1967; Watts & Anderson, 1971). In general, these studies have shown that people perform better on criterion tests of text comprehension if they were previously given orienting instructions or priming questions regarding the text. The summaries could be viewed as an extreme version of how to focus attention.

The second argument, the spacing of study time view, is supported by a large body of verbal learning literature that shows that for a given amount of study or rehearsal time, subjects remember much more when that study time is distributed rather than massed (e.g., Gartman, 1972; Glenberg, 1976; Hintzman, 1969; Madigan, 1969; Melton, 1970). One can view the prose version as forcing subjects into massed practice, viz., to pay attention to one idea (a main point and its embellishments) for a long time, thereby having too little time to return to that idea later.

Our previous studies did not allow us to pull apart these two possible explanations for the summary

superiority. Conceivably only the absence of details caused the advantage for summaries; possibly only the spacing of practice caused the advantage, or perhaps both factors have an effect on learning and retention.

The present set of experiments were designed to pull apart these two potential causes. This required going to a less "naturalistic" task. In the previous experiments, the prose condition allowed subjects to read, at their own pace, photocopies of the original text book passages. The summaries were also read at a subject's own pace. In the present experiments, subjects read all material on a computer-controlled video monitor. We orthogonally varied whether subjects studied embellishments with the main points and whether the equivalent study time was massed into one trial or distributed over three trials. The embellished, "massed" condition most closely approximates the normal prose condition; the unembellished spaced condition resembles the summary condition.

Experiment 1

Method

Four topics were selected for subjects to study. Subjects studied one topic in each of the four conditions: embellished-massed; embellished-spaced; unembellished-massed; and unembellished-spaced. In the embellished-massed condition, a main point plus three details were presented on the screen at one time. These were displayed for a total of 42 seconds before the screen was erased and a new set of facts were presented. In the embellished-spaced condition, subjects saw one main point plus one detail on the screen at a given time. The fact and detail were presented for 14 seconds of study. Then the screen was erased and a different main point and embellishment were presented on the screen for study. The program cycled through all the main points in this manner. Then it went through the main points a second and a third cycle, each cycle

with a different embellishment. In the unembellished-massed condition, a point was presented only once, but for 42 seconds. In the unembellished spaced condition, a main point was presented in isolation on the screen for 14 seconds, and then replaced by another fact. After all main points had been presented, the screen would cycle through the same main points again for a second time, and then a third time.

Order of presentation of the four topics for study was randomly determined as was assignment of topics to conditions under the constraint that the assignment of topics to conditions and order of conditions was counterbalanced over subjects. After subjects completed studying one topic, they were asked questions about the material. After studying all four topics, they were asked more questions about each topic, in the order that they studied those topics. This second set of tests is referred to as delayed testing. The questions were all true/false. Latencies were surreptitiously recorded (in seconds) from the onset of the question until the response. The primary dependent measure was accuracy. Feedback concerning accuracy was not given.

Materials

Four topics were chosen from introductory texts in four different fields: photography (Introduction to Photography by Rhode and McCall, 1971), ecology (Ecology and the Quality of our Environment by Southwick, 1972), African economic geography (The Geography of Modern Africa by Hance, 1975), and Russian Revolutionary history (Russia: A short history by Florinsky, 1969). For each topic, 32 main or central points were isolated for each chapter with three embellishments per point. Both the main points and the embellishments were from the original text. Only minor changes in wording of any sentence was necessary. Thirty-two true/false questions were constructed to tap comprehension of each main point. Care was taken so that no true/false questions were answered much above or below chance accuracy (50%) by subjects who had not studied the material. Pilot subjects screened

our materials. Any questions answered significantly above or below chance were replaced by other questions that were also checked. An example of some main points, their embellishments and their true/false questions are given in the Appendix.

Subjects

32 subjects participated in the experiment in partial fulfillment of a requirement for their psychology course. The experiment took approximately 2 hours and they received 2 credits out of the required 3. A design that balanced four topics, four conditions, and four presentation orders, required 16 subjects. So there were two subjects per design instantiation.

Results

Table 1 presents the accuracy and latency results of Experiment 1. The data come from eight conditions which are all combinations of the factors immediate vs. delayed test, spaced vs. massed practice and embellished vs. unembellished main points. The latencies are mean time to answer all questions whether the answers were correct or not. We are simply using these times as a gauge of the difficulty of a condition. An analysis of variance was performed on the accuracy data using the above factors and treating the subject by factor interactions as the error terms for each factor. A separate analysis using the same factors was performed on the latency data.

Consider first the accuracy data in the immediate conditions. There is an advantage for spaced practice and an advantage for unembellished presentation of the main points. In the delayed condition, neither effect is maintained. At delay, spaced-embellished is better than massed embellished, and massed-unembellished is a more accurate condition than massed-embellished, but there appears to be one aberrant cell, viz., the unembellished-spaced condition. If the value in that cell had been elevated, there might have been more statistically significant effects. Only the effect of embellishment was reliable overall, $F(1,31) = 7.36; p = .01$, such that subjects are still better off learning

Table 1

**Mean Proportion Correct
and Latency (in parentheses, in seconds)
as a Function of Spacing, Embellishment and Delay
in Experiment 1**

	IMMEDIATE		DELAY	
	SPACED	MASSED	SPACED	MASSED
Embellished	.697 (6.78)	.680 (7.73)	.719 (5.60)	.650 (6.14)
Unembellished	.750 (6.84)	.715 (7.30)	.681 (5.68)	.709 (6.09)

without details. The effect of spacing was not significant (report F value). There was a marginally significant triple interaction of embellishment, spacing and delay, $F(1,31) = 3.56, p < .07$. The latter effect is probably spurious due to the especially low cell mentioned above.

We were surprised not to find a significant effect of spacing as one finds in most learning situations. However, for several reasons we did not abandon the notion that spacing would have an effect. One reason was the latency data also displayed in Table 1. Subjects are significantly faster to judge probes when the relevant information had been studied in spaced rather than in massed form, $F(1,31) = 10.17; p < .01$. So rather than large differences in accuracy, the advantage of spacing was manifest in latencies to respond to the questions. There were no other significant effects on the latency measures.

The second reason why we felt the experiment may not have indicated as strong a role of spaced practice as warranted was due to the nature of our dependent measure. True/false questions may not have been sensitive enough to accurately reflect learning differences. Others have found that spacing effects are weaker in a recognition task than in a recall task (e.g. Gler.berg, 1976; Ross and Landauer, 1978). To discover whether the small effects were due to the nature of the criterion task, we decided to replicate Experiment 1 using a more sensitive retention test.

Experiment 2

In this experiment our dependent measure was accuracy to answer probe recall questions rather than true/false questions. The questions tended to be "wh" questions, e.g., "What keeps solutions uniform, thereby avoiding streaks on the negatives?" or "To whom did the Emperor abdicate?" We

thought that this might provide a more sensitive measure of differences in learning than did the true/false questions; with greater variance in the means, we hoped to see strong effects of our manipulations. In all other respects, the second experiment was a replication of the first.

Method

Again, there were four topics and four conditions, the same as those used in Experiment 1. Presentation order of topics and assignment of topics to conditions were randomly determined for each subject, using the same constraints as had been used for counterbalancing in Experiment 1. The material was again presented on a computer controlled video-terminal. Half of the questions were asked after studying each passage. The remaining questions for all topics were asked after all four topics had been studied. Subjects were not given feedback as to the accuracy of their responses. The experiment took between two and three hours to complete.

Materials

Each of the four topics, ecology, geography, photography and Russian history, had 32 main points. For each main point, one question was constructed. Typically the subject (focus) of the sentence or some part of the predicate was deleted and the sentence was transformed into question format. The Appendix gives some examples of questions used.

Subjects

Thirty-two subjects participated in the experiment so that we had two subjects per cell instantiation of the counterbalancing design. The experiment took 2 and one-half hours. Subjects either received 2 credits and \$2.00 or 1 credit and \$5.00.

Results

Table 2 presents the accuracy data for Experiment 2 for the eight conditions. In this experiment, response times were not recorded since subjects had to type in a phrase rather than select one of two

Table 2

Mean Proportion Correct as a Function of Spacing,
Embellishment and Delay in Experiment 2

	IMMEDIATE		DELAY	
	SPACED	MASSED	SPACED	MASSED
Embellished	.662	.504	.523	.474
Unembellished	.775	.701	.661	.607

keys. The scoring of the answers, of course, required some degree of subjectivity. A scorer was presented, by computer, with the answers of all subjects to each question. The scorer rated each answer right or wrong. In that way consistency in ratings could be maintained and the rater was blind to condition of the response.

As before, there was a significant effect of embellishment, $F(1,31) = 90.04$; $p < .001$, such that subjects were better off studying the material without the "aid" of supporting details. This time, however, there was also a main effect of spacing, $F(1,31) = 21.51$; $p < .001$, such that subjects answered questions more accurately if they had studied the topics with distributed (or spaced) rather than massed practice. There was also a main effect of delay, $F(1,31) = 74.33$; $p < .001$; subjects remembered more immediately after studying the material than they did an hour later.

There was also a significant interaction of spacing with delay, $F(1,31) = 5.14$; $p < .05$. For some reason the benefit of spacing decreased with delay. This contradicts results such as those of Glenberg (1976), where benefit has been shown to increase with delay. However, in these other experiments, the short delay is on the order of a few seconds, not one-half hour. It is also worth noting that, in this experiment, unlike Experiment 1, the unembellished-spaced condition at delay is not an aberrant point with respect to the main effects of spacing and embellishment.

Discussion

Both experiments indicate that there is a clear advantage of presenting material in an unembellished form and that this result is independent of the spacing of study. In Experiment 1, using a recognition memory paradigm, this advantage was only 2.7%, while in Experiment 2, using a recall measure, the size of this effect rose to 14.5%. Both experiments indicated an independent advantage

of spacing (2.3% in Experiment 1 and 8.4% in Experiment 2.) The percentage recognition measure in Experiment 1 was not significant but there was a significant latency advantage for the spaced study condition. These results imply that in our previous experiments (Reder and Anderson, 1980) where embellishments and spacing were confounded, subjects were at a double advantage in the summary condition, receiving benefit both of spacing and lack of embellishment.

The clear implication of this research is that human memory should be considered a severely limited storage system. Providing a student with embellishments of a main point will take processing away from the main point and leave it at a disadvantage. The strong relationship that exists between the embellishment and the main point does little or nothing to promote memory for that main point.

The pedagogical implications are also clear. In writing texts, one should be judicious in introducing details. Quite probably details do serve functions such as increasing interest and credibility. They also serve to acquaint the student with the argument structure of the field. However, they also seem to have a cost in terms of hurting memory for the central ideas. That cost should be weighed carefully against those possible benefits.

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Appendix

Below are three example main points, each with embellishments. Each set of facts is followed by a true/false question and a short-answer question.

Example 1

Main Point

Temperature below or above the recommended standards can change the chemical activity of development.

Embellishments

Developing at temperatures higher than 80 degrees is inadvisable because of the possibility of damaging the emulsion layer of film

To develop at below 60 degrees is inadvisable because film developers do not function properly.

Laboratory thermometers must be accurate and checked regularly with a second thermometer.

True/False Question

Temperatures below recommended standards will change the chemical activity of development, but temperatures above the standard are not as harmful.

Short-Answer Question

What can change the chemical activity of development?

Example 2

Main Point

Agitation keeps the solutions uniform, so that streaks on the negative caused by excess solution do not occur.

Embellishments

Agitation should begin the moment the film is placed in the developer and continue for the first five seconds of the development period.

Agitation should be used for about 5 seconds out of every 30 throughout the development process.

Extreme agitation gives graininess to the image.

True/False Question

Agitation is described as solutions leaving streaks on the negatives.

Short-Answer Question

What keeps solutions uniform, thereby avoiding streaks on the negatives?

Example 3**Main Point**

Development of sheet film involves placing each piece of film onto individual hangers which are lowered into the tank.

Embellishments

Hangers should strike the edge of the tank to knock off air bubbles.

Agitation should be produced by lifting the hangers up and down.

All the hangers should be lifted together to avoid having the corner of one scratch neighboring film.

True/False Question

Sheet film can be developed if each piece of film is hung on separate hangers and lowered into a tank.

Short-Answer Question

What kind of film is hung on individual hangers and then lowered into the tank?

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